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Validity of an Electronic Based System (*Training Tester*™) to Measure the Release Height at the Team Handball Jump Throw

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Abstract The purpose of this study was to examine the validity of an electronic based jump measurement system (*Training Tester*™) to measure the release height at the team handball jump throw. As reference criterion a Vicon MX™ system was consulted. Twelve male elite junior team handball players performed, after a standardized warm-up program, several jump throws in a team handball game-related environment. The result of the best successful jump throw was used for further data analysis. Release height was determined simultaneously with the *Training Tester*™ and the Vicon MX™ system. Subjects achieved significantly (t = - 2.597, p = .025) greater release heights with the Vicon MX™ system (267.92 ± 14.45 vs. 265.83 ± 15.96 cm). However, Pearson correlation coefficient between both measurement methods was found to be very high (r = .988, p < .001). Consequently, criterion-related validity of the *Training Tester*™ could be demonstrated. In conclusion, the *Training Tester*™ provides a portable, cost-effective and time-saving tool to measure the release height at the team handball jump throw and can be described as well-proven alternative for testing in field situations.

Keywords Field Test, Jump Measurement System, Jump Test, Sport Specific

1. Introduction

The ability to jump as high as possible is a main influential factor of team handball game performance[13]. Typically, the jump performance of team handball players is evaluated by calculating the vertical jump displacement at a squat jump or a counter movement jump[2,5,7,8,9,10,11]. However, Ferreira and colleagues[6] pointed out that in many sports the final reach height instead of the vertical jump displacement is the crucial variable. This is partly also applicable for team handball because the release height at the jump throw is a second important performance-determining factor besides the jump height[14]. The jump throw represents the most frequently used shot on goal[17,18]. Without a sufficient release height the offensive player cannot throw over the defender and the shot on goal will be blocked and not successful.

With force plates, switch mats and usual jump and reach devices it is impossible to measure the release height. The video analysis is a suitable method for the determination of the release height, but inappropriate for field testing[3,4,15]. A new innovative jump measurement system is the *Training Tester*™ (BZ Hi-Tech S.r.l., San Martino di Venezze, RO, Italy). The *Training Tester*™ is electronic based on optical sensors equipped with infrared technology and displays maximal reach height in real time with intervals of 1 cm in a range between 211 cm and 389 cm. This device has no vanes like traditional jump and reach devices and allows the assessment of the release height at a jump throw.

Surprisingly, the validity of the *Training Tester*™ to measure the release height at the team handball jump throw has not been examined to our knowledge. Therefore, the aim of this study was to assess the criterion validity, which is based on the comparison between a new method and an as gold standard recognized criterion measure[12,16], of the *Training Tester*™ to measure the release height at the team handball jump throw by comparing the *Training Tester*™ with the motion capture method.

2. Methods

Experimental approach

The criterion-related validity of the *Training Tester*™ to measure the release height at the team handball jump throw was determined by comparing results of the *Training Tester*™ with data obtained simultaneously from the motion capture method.

Subjects

Twelve male elite team handball players volunteered to take part in this study and gave their written informed

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consent. Their age, height and body mass were 17.4 ± 1.2 years, 185.8±7.8 cm and 80.2±11.6 kg, respectively. Without exception, all subjects played in the supreme German junior league. The procedures undertaken in this study were approved by the local ethics committee and are in compliance with the Helsinki Declaration.

Procedures

At the beginning, the subjects completed a standardized warm-up program consisting of a general part and a specific part. The general part was 5 min moderate cycling with 1 W per kilogram body weight at 60-80 rpm. The specific part contained five counter movement jumps, five overhead throws against a wall and five jump throws, each with medium intensity. After the warm-up procedure, subjects standing reach height was measured flat-footed. Then, the height of the *Training Tester*™ was adjusted according to subjects standing reach height. The correct jump throw technique was conveyed via verbal instruction and a video demonstration. The subject's task was to start from a self-determined position with the ball and to accomplish two in-run steps before jump off with one leg as high as possible (step sequence for right hander: right – left – jump, step sequence for left hander: left – right – jump). Furthermore, the subjects should release the ball at the highest possible point in the air and throw as strongly and as accurately as possible on the target area which was top right in the team handball goal for right hander and top left in the team handball goal for left hander. The subjects were instructed, to choose a take-off position that allowed them to achieve the marked line at the highest point in the air. This marked line was 10 cm in front of the measuring zone of the *Training Tester*™. Subjects completed several sample trials and got feedback about execution. Afterwards, they performed five test trials with a break duration of 30 s. In case of a non-successful jump throw, defined as a throw which failed the team handball goal, the test trial was to be repeated. To simulate a team handball game-related situation, four Air-Bodys® (MGT-Sports GbR, Backnang, Germany) were used as an opposing defensive line. The Air-Bodys® were placed 75 cm apart from the measuring zone of the *Training Tester*™. The distance between the marked line and the team handball goal was 8.1 m. Figure 1 shows the jump throw test set-up and realization. Each subject was tested separately and requested to achieve maximal performance.

The motion capture method was based on a Vicon MX™ system (Vicon® Motion Systems Ltd., Oxford, UK) with two MX™-3 cameras and four MX™-T10 cameras at a sampling frequency of 200 Hz. One retro-reflective marker (14 mm) was attached to the middle finger of the subject's throwing arm. Two retro-reflective markers (14 mm) were placed on the handball (Molten® HX 4000; Molten® Corp., Hiroshima, Japan). Vicon MX™ system data were recorded and evaluated with Vicon Nexus™ version 1.7 (Vicon® Motion Systems Ltd., Oxford, UK). As reference value for the test results of the *Training Tester*™ the real achieved release height was determined. The real achieved release height was defined as the highest point of the ball at the moment when the distance between the marker on the middle finger and the center of the ball started to increase continuously. To assess the center of the ball, the mean value between the two ball markers was calculated. To receive the highest point of the ball, the radius of the ball was added to the center of the ball.

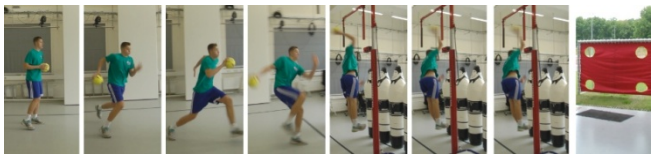

Figure 1. Jump throw test set-up and realization

Statistical analyses

All statistical analyses were carried out using the statistical software IBM® SPSS® Statistics version 21 (IBM® Corp., Armonk, NY, USA). Results are shown as means ± standard deviation from the best of five trials. The normal distribution of the variables was tested by a Kolmogorov-Smirnov test. Student's t-test for paired data was carried out to analyze whether differences existed between means of the two methods. The Pearson product moment correlation coefficient was used to determine correlation between the methods. Furthermore, a Bland Altman plot was created to examine measuring agreement[1]. An alpha of 5% was accepted as statistically significant.

3. Results

The mean values and standard deviations of release heights and the Pearson product moment correlation coefficient to determine correlation between both measurement methods are depicted in Table 1.

The Vicon MX™ system measured significantly (t = -2.597, p = .025) greater release heights (267.92 ± 14.45 vs. 265.83±15.96 cm) compared to the *Training Tester*™ (Table 1). But, Pearson correlation coefficient was very high (r = .988, p < .001). Figures 2 and 3 show the linear regression and Bland Altman plot for variables of interest.

Table 1. Values of mean release height and standard deviation (*SD*) measured by *Training Tester*™ (TT) and Vicon MX™ system analysis (VA). Pearson correlation coefficient (r) and paired sample Student's t-test (t) with p-values between methods

	TT mean (*SD*)	VA mean (*SD*)	Pearson r (p-value)	Student's t-test t (p-value)
Release height (cm)	265.83 ± 15.96	267.92 ± 14.45	.988 (< .001)	- 2.597 (= .025)

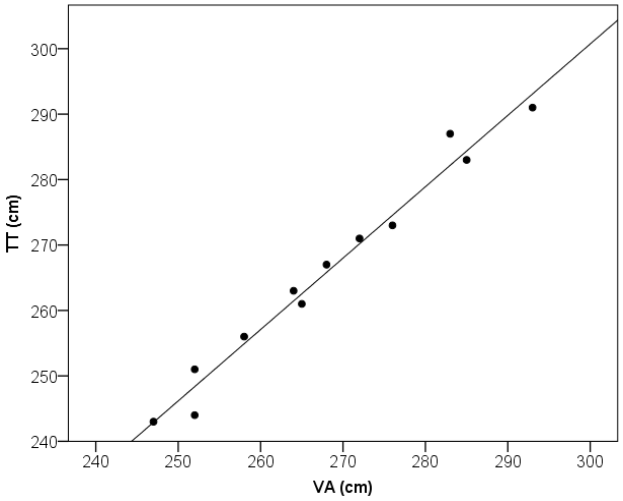

Figure 2. Correlation and linear regression for release height with *Training Tester*™ (TT) and Vicon MX™ system analysis (VA)

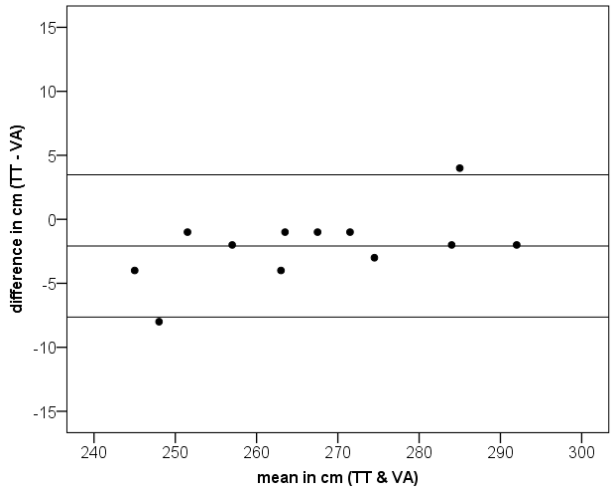

Figure 3. Bland Altman plot illustrating absolute differences of release height between *Training Tester*™ (TT) and Vicon MX™ system analysis (VA)

4. Discussion

The release height at the jump throw is an important performance-determining factor in team handball[14]. Established jump measurement methods like force plates, traditional jump and reach devices with vanes, switch mats and video analysis are inappropriate to measure the release height or very elaborate[3,4,15]. Therefore, the purpose of the present study was to assess the validity of the electronic measurement system *Training Tester*™ to measure the release height at the team handball jump throw. For evaluation of validity, the motion capture method with a Vicon MX™ system as criterion measure was applied.

The different release heights between *Training Tester*™ and Vicon MX™ system were systematic but only minimal. This underestimation of release height with the *Training Tester*™, however, can be explained by the smaller measuring zone of the *Training Tester*™ compared to the Vicon MX™ system and the variability in the jumps. The subjects reached the highest possible point in the air often before or after the measuring zone of the *Training Tester*™. Nevertheless, the Pearson correlation coefficient between the two methods was very high. As a consequence, the *Training Tester*™ jump measurement system can be considered valid to assess the release height at the team handball jump throw.

An interesting research outlook consists in the determination of reliability and validity of the introduced jump throw test procedure with the *Training Tester*™.

5. Conclusions

Executing jump throws with the *Training Tester*™ shows an underestimation of release height in comparison to Vicon MX™ system data. The difference is systematic and can be explained by the relative small measuring zone of the *Training Tester*™. However, correlation between both measurement methods was found to be very high. Thus, the electronic based system *Training Tester*™ provides a portable, cost-effective and time-saving tool to determine the release height at the team handball jump throw and can be described as valid alternative for field testing.

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